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From Chas. Hall Esq. of Liverpool
with the author's compts

PROGRESS MADE

IN THE

APPLICATION OF THE MONCRIEFF-SYSTEM

TO

LAND AND NAVAL ARTILLERY, AND TO COAST WORKS.

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THE PROGRESS THAT HAS BEEN MADE IN THE APPLICATION OF THE MONCRIEFF-SYSTEM TO GARRISON SIEGE, AND NAVAL ORDNANCE, AND TO COAST WORKS.

From the JOURNAL *of the* ROYAL UNITED SERVICE INSTITUTION, *vol.* XIV.

(*Authors alone are responsible for the contents of their respective memoirs.*)

Evening Meeting.

Monday, April 4th, 1870.

Lieut.-General the Hon. Sir JAMES YORKE SCARLETT, G.C.B., in the Chair.

THE PROGRESS THAT HAS BEEN MADE IN THE APPLICATION OF THE MONCRIEFF-SYSTEM TO GARRISON, SIEGE, AND NAVAL ORDNANCE, AND TO COAST WORKS.

By Captain A. Moncrieff, Edinburgh Artillery Militia.

The Chairman: I have the pleasure to announce that five annual members have joined the Institution since our last meeting. I only wish there had been more, as we wish to have as many members as possible. I do not think the Institution is sufficiently known in the Army, or sufficiently patronized. I can only say that I shall be happy to double my subscription if it is wanted; but we do wish to get as many members as possible to join the Institution.

But to proceed to the business of the evening, Captain Moncrieff, of the Edinburgh Militia Artillery, will now explain to us the progress that has been made in the application of the Moncrieff-System to garrison, siege, and naval ordnance, and coast works. I believe most of you have some knowledge of the gun-carriage which he has invented, and the processes by which it is worked. He will give us further information to-night, and probably describe some improvements he has made in the system.

Captain Moncrieff: Since I first read a paper in this theatre, the subject of it has had an eventful history. The system which now

bears my name is gradually, but surely, becoming acknowledged and acted on, both at home and abroad.

This system consists of three parts—

1st. Of various contrivances for dispensing with a raised parapet for artillery, by means of counterweights, &c.

2nd. Of arrangements for placing the artillery so mounted in favourable positions.

3rd. Of arrangements for laying, sighting, range finding, internal communication, &c., adapted to the altered conditions and requirements of a position thus armed.

The system may be said to have two aspects, an artillery, and an engineering one, both of equal importance; and in applying it properly, both must be kept in view, in order to get the full advantage it is capable of yielding.

The gun carriages have to be made with those appliances which will best suit them for the positions in which they will be placed, and on the other hand the works themselves should be designed in such a manner as to get the greatest results from the artillery mounted on the new plan.

It is difficult fully to appreciate the radical change of conditions imported by the new system, without actually attempting its application. Up to the present time the trace of works and the systems on which they were formed, were based to a great extent on conditions that are now removed. These conditions, simple as they were, guided nevertheless the pencils of all military engineers, from Vauban downwards, and gave form to those many lined and cunning designs for flank defence characteristic of modern fortification. An exterior slope, a pierced parapet, guns cramped in their action and lateral range, such were the conditions which are now swept away by the new system.

The problem of fortification is thus far simplified. This advantage, however, would probably not have been sufficient to force on a cordial recognition of the new system at present, had it not been for the wonderful advance that has taken place in our own time, in the science of artillery.

The penetration and precision of direct rifle-fire from modern ordnance called for stronger parapets, and smaller embrasures. The old earthen or masonry parapet, which was sufficient to resist ordinary spherical shot, could not withstand the elongated rifle projectiles; and that parapet had not only ceased to be a protection, but actually became a danger, as it just offered sufficient resistance to burst large shells, or was thrown in upon the detachments by solid projectiles.

These potent reasons compelled the use of iron shields, casemates, and turrets.

The great progress, however, in the science of artillery since 1855, has been restricted mostly to the guns themselves. The carriages for these guns were certainly improved, or they would not have been sufficient for their work; but that improvement was confined to increased strength, and to various methods of stopping the recoil by friction, by the use of compressors, &c.

The violent nature of the force of recoil in the new artillery was,

and is, a constant source of difficulty and expense, but I trust it has now been successfully grappled with, not by improving this old system, but by changing it completely, and by utilising the recoil; thus on the one hand getting rid of the principal difficulty, and on the other avoiding the necessity for using iron, which, as before stated, had become the only alternative.

It is not necessary to dwell on this subject, as you are already acquainted with my method of procedure. I shall now offer a short description of a few of the designs of Moncrieff carriages that have been proposed, and which are now being carried out for the British Government.

A great proportion of the whole work in the Royal Carriage Factory during 1869 consisted in manufacturing the 7″ muzzle-loader 7-ton Moncrieff carriages now in the service. This carriage is very much the same as the first one experimented on at Shoeburyness. It differed only in some improvements in the gearing and other alterations made by me after the decision to adopt it was taken. Next in order I shall take the 9″ 12-ton muzzle-loader Moncrieff carriage.

It will be noticed that in this case there is a great change in the arrangements adopted. Some objections were made to the 7″ 7-ton carriage, because with it there was only 3′ 6″ between the height of the gun in the loading and firing positions. The cover thus afforded was considered to be barely enough. I have accordingly met this objection in the 9″ 12-ton carriage, by making the gun descend 6 feet by the recoil, thus giving much greater cover. The men while loading are protected overhead by the counterweight, although that protection may be said to be almost unnecessary; but a stray splinter might by chance descend vertically, if so, the counterweight would form a strong roof to intercept the falling body. The top of the counterweight is under the crest, and is shaped so as to throw off any shot or splinters that might impinge on it.

In this carriage, the gearing is changed completely, and it will be observed that it is all brought down much nearer to the ground than in the 7″ 7-ton carriage, and to a convenient position for the detachment.

Various other improvements have been designed for this important class of artillery in the way of making it more simple and less expensive, but I trust I may be excused for not entering into all such details, as in my present position it would be unadvisable.

Besides the designs for 7-ton and 12-ton M.-L. guns, a number of other designs for smaller artillery are being matured; and at the same time my labours are being applied to the means of mounting still heavier artillery than any to which the system has been yet applied. I may also mention that designs for 7 in. breech-loaders and 98 cwt. guns were last year submitted to the Director-General of Ordnance, for Moncrieff carriages, in which the recoil is received on springs. These carriages have parallel action and fixed fulcra, and are the same as one of the designs submitted to General Sir R J. Dacres, K.C.B., in 1858, and reported on by him to the then Secretary of State for War. They have lightness and compactness to recommend them. On some future

occasion I may have the pleasure of exhibiting some of these at this Institution. A Committee has been lately appointed to experiment on, and, if approved of, to pass my new designs into the Service.

I shall now shortly refer to the application of the system to existing works.

Before doing so, however, I shall take the opportunity of mentioning a fact which is not disputed, but which is not considered in estimating the comparative values of the old and the new systems. This fact has so important a bearing on the question, especially in relation to coast-batteries, that I trust I may be excused for insisting on it here. It is one of those facts that entirely escaped the observation of artillerists, except perhaps men of great practical experience, who did not take an opportunity of recording results, but only acted on them.

General Sir Linton Simmons had the merit of not only discovering this fact, but of enunciating and proving the law on which it rests, from the statistics of a lengthened series of experiments at Shoebury-ness. He brought this forward at a discussion at the War Office on one of the professional papers of the corps of Royal Engineers, contributed by me.

The law is, that the mean error to the right or left of a vertical line in artillery practice, is nearly as the distance; but that the mean error above or below a horizontal line, goes on in an increasing progression with the distance.

It is only necessary to state this, to make it at once apparent, that as long as this law holds good, the exposure or liability to be struck in the two cases must not be estimated alike.

The two cases are these:—

1st. That of the old system, which has an exterior slope, a wall, a shield, or casemate, with their ports; all of them standing a given height above the line of glacis, and visible to the enemy.

2nd. The other case, viz., the new system, in which the vulnerable area exposed to direct fire is only a horizontal line, presenting nothing visible to the enemy.

The gun is exposed in both cases, in the latter, only while firing; in the former, it is somewhat covered when the ports are very small, but is permanently exposed.

To illustrate this practically, let any good rifle shot be asked what would be the comparative chances of hitting a target facing him vertically, or of planting a bullet on it while it lay flat on the ground.

The danger of the exposure of this narrow horizontal line has not had any deduction made from it on account of the difficulty of hitting it by artillery fire.

It is very true that there is a heavy enough balance in favour of the new system, without adding this consideration; but I submit that it is a good deal more important than would appear at first sight, and in taking a general survey of any position with a view of planting batteries, it would be a mistake to ignore the consideration. This, in conjunction with the invariable experience of naval attacks on land works during the American war, formed part of my reasons for recommending the 4th provision to be attended to in laying down

Moncrieff batteries for coast defences referred to in another part of this paper.

The adaptation of the new system to existing works gives rise to questions of great difficulty and embarrassment, which do not exist when new ground has to be broken, and where the system can be applied in a complete manner.

When the existing coast batteries were laid down, the conditions of naval attack and defence were very different from what they now are. Some of our coast batteries are very powerful works. It may be said of others that they are not well suited for the new conditions. But as a great deal of money has been expended on them, and many still fondly cling to the traditional methods handed down to us, the question becomes a compromise between the two systems; and the object is to get as much advantage as possible by their combination.

When the Government made arrangements with me in regard to the adoption of my system, it was provided that in all cases where that system was applied, the designs for the works were to be submitted to me, in order that I might have an opportunity of making my remarks in writing thereon, for the information of the Defence Committee, before their final decision was given. This duty I feel to be at once a great responsibility and a privilege. It was certainly right, that while the old system had so many supporters who were well acquainted with it, and who could ably place its advantages before the judges of the impending change, the new system should at least have one advocate well acquainted with its provisions; and its author was likely to be best acquainted with his own system, and was on that account a suitable person for this duty.

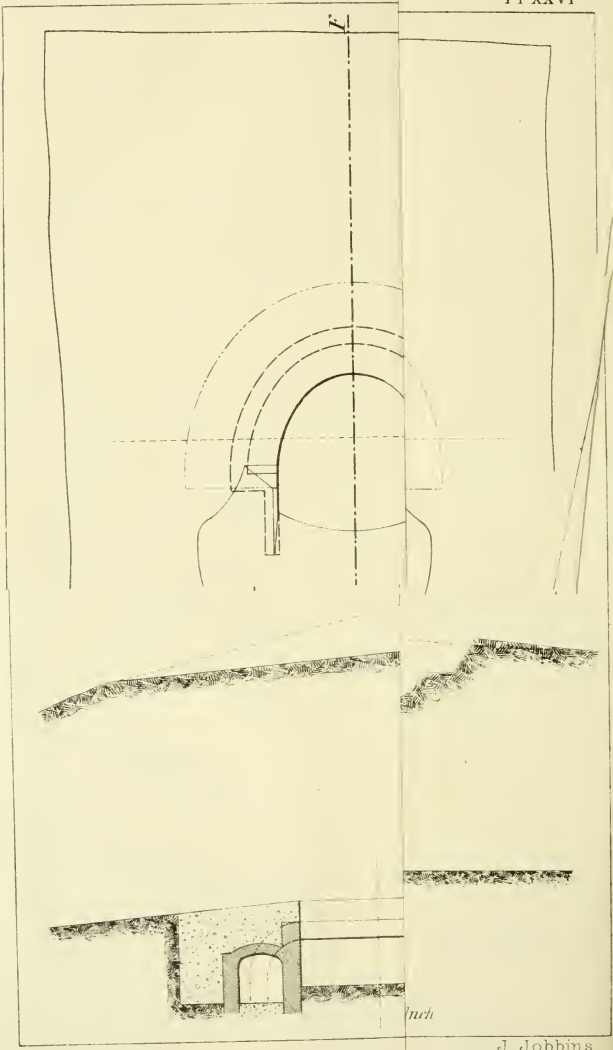
I sincerely trust that I may be able to give complete satisfaction to the Defence Committee in this capacity, and be considerate and explicit when called on to state the aspect of each case from my point of view.

I have myself only studied the question thoroughly in relation to coast defences, in order to form out of it a consistent whole, in which the carriages, the formation of batteries, and the position of the guns in relation to one another, as well as the tactics that belong to the new dispositions, might all receive consideration in relation to each other; and it will be found that my carriages consequently possess all the appliances for working this system in its mature state.

If time admits I shall endeavour to explain some of these arrangements, although it will be impossible to do so in much detail, as I have a new subject to explain at the end of this paper.

The conditions of coast defence vary very much in different cases, and therefore no general law can be laid down. It sometimes is required to stop the passage of a navigable river or channel, in conjunction with marine obstacles, and mines or torpedoes; in other places to guard the approaches to a harbour, dockyard, or arsenal; or it may be merely required to prevent a hostile landing.

Batteries sometimes are embraced within an armed position, and do not require provision for flank defence; or they may be exposed to a rush, and provision against this, would be an element in their disposition.



J Jobbins

The ground will sometimes afford the advantage of low and inaccessible mud or sand banks, where the guns could be mounted to greatest advantage, à fleur d'eau; high command in other cases, would place the artillery at considerable advantage.

In any case, however, in which Moncrieff batteries are used for coast defence, I think the system is best carried out when the following conditions are attended to :—

1st. That the guns should be scattered, so as not to draw converging fire from ships, but to be able to converge their fire on them; and so that they shall not be encumbered in action by their own smoke.

2nd. That all natural advantages should be seized as a means of disguising or masking the exact position of the guns.

3rd. That the guns should be so arranged as that each shall have as great an opportunity as possible of using the new powers of traversing conferred by the system, either in attacking the ships, or in covering the ground in front of other guns.

4th. That batteries should be generally well retired from the channel, so as not to be readily approached from ships, and so that the increased precision of land-fire over ships'-fire would tell to their advantage.

5th. That provision for protection to the men should be made by giving them a space well defiladed for working in, and bomb-proof cover, if it can be afforded.

6th. By attending to the materials used in forming the superior slope, the angle of which should always be sufficiently low as to cause ricochet with such material as may be used.

On account of evidence given by me before the Committee on Fortifications, the Secretary of State for War called upon me, through the Director of Works, on the 15th June, 1869, to give in designs on my system for several positions, consisting both of adaptations and of entirely new works. The most important of these is Cliff End, Isle of Wight; it is calculated to cost a very small sum, as designed by me, and has an armament of twenty heavy guns. On account of the ground selected, I venture to say that there is no coast work in England, whatever it may have cost, that an impartial judge will pronounce more formidable, in its particular position, than this work. If now carried out, it will be the first pure Moncrieff work of any importance made in this country.

There is another aspect of this important question which should not be overlooked, viz., the capabilities of the new system as applied to extemporized works. Whenever the strategical questions connected with the defence of the whole country are considered, the enormous importance will be recognized of being able to form earthen batteries at comparatively short notice, equal to cope with ironclad vessels with heavy guns; in other words, to retain the power of being able to develope the defence where attack is expected. The time may arrive when the suggestions made in previous papers of mine on this subject will be carried out; when positions of importance will be acquired by Government and the ground prepared to a certain extent, but not so far as to require maintenance, or to be quite ready for its

armament. It is a satisfactory consideration that the net work of railways in Great Britain, if only slightly extended on strategical principles, is capable of supplementing its existing defences to an enormous extent at a comparatively small expenditure.

The formation of coast roads; of a few depôts of heavy artillery *matériel* at the conjunction of railway lines; and an organization capable of applying all the advantages of internal lines of communication such as probably do not exist to the same extent in any other country, should go some way to meet the increased power of attack that steam navies confer on an invader.

Regarding the 6th or last provision recommended in erecting Moncrieff batteries, I am unable to give you much information. It would be possible to say a good deal about the best kind of armour for shields, as many experiments have been made to determine this; but although the other question applies to both the old and new systems, no proper experiments have yet been made for it, and consequently the theories on the powers of different substances to deflect rifled projectiles at small angles are all founded on the loosest data.

It is generally quite forgotten by the lovers of iron that the sill of a shield or embrasure, or the base of an iron casemate, is probably more liable to be injured by a shot than the crest of a Moncrieff emplacement.

I have not been able to do as much as I could wish lately in developing a most interesting part of the new system, viz., the 3rd part, from the great press of work that has fallen on me in connection with the others.

This 3rd part consists in the arrangements for range-finding, internal communication between the batteries, provisions for working in concert during action; in fact, the tactics of the new system, and the appliances for carrying them out.

With the magnificent and costly artillery that must now be used against ships, it would be a mistake of the most inexcusable kind to neglect the means of making the fire of the guns as effective as possible.

A 600-lb. shot which misses is as harmless, although much more expensive, than an old 32-pounder; and to find the range by trial shots is both a rude and unsatisfactory means of attaining the object in view. My method is the following:—

A long base line within the position is selected, and the whole channel is laid down on a chart, with radial lines from points at the extremities of this base.

The exact position of any point on the chart can thus be described by two angles, these being the angles between the base line, and lines from its extremities to the point referred to, read at such points of observation.

Each gun is provided with a copy of this chart, which at the same time has its own position or pivot laid down; radial lines from that point correspond with a graduated racer, and enable the gun to be traversed while in the loading position, and to fire on any required part of the channel.

At the same time concentric lines, indicating the range of the gun, enable the detachment to determine the required elevation and give it by means of the trunnion-pointer, or platform tangent-scale.

The possibility of laying correctly by these appliances has been proved by experiment.

Means are provided for giving, by electric wire at each gun, the angles from the two points of observation. The chart at once indicates by inspection (from the two angles formerly referred to) the position of the vessel, the point to which the gun should be trained, and the elevation that has to be given by means of trunnion-pointers.

The gun can thereby be laid correctly without calculation or delay, and, if the object is moving, it is laid in front and fired at the proper moment by watching the transit of the vessel across the field of the Moncrieff reflecting sight.

Electric instruments have been designed by me for indicating the position of a ship at each gun mechanically. When the vessel is obscured by darkness or smoke the guns can be correctly directed on it and fired by electric fuses, or by electric signal from the point of observation, where its position can be determined by powerful night glasses or otherwise. These few remarks convey but very inadequately the simplicity and completeness of the proposed method. All my carriages are provided with the means of carrying it out. It would require a separate lecture to describe the details of the method properly, and I trust you will excuse this short and imperfect description.

Besides the general means for determining ranges above referred to, each battery should have independent means of doing so. This would be the more necessary for guns having considerable command, as a smaller error in that case, would carry the shot over, or under the vessel. I have designed an instrument that will give the distance with considerable accuracy in batteries of high command by the measurement of the vertical angle.

The drill of the artillery would be regulated, and its efficiency judged, by the alacrity with which it could direct its fire on rapidly-moving, or imaginary objects, the practice being carried out in concert under the immediate orders of the officer conducting the supposed defence. In connection with this part of the subject, are the arrangements for connecting the batteries by proper and covered roads, together with lines for infantry, and for the passage of reliefs; also the occasional disposition of howitzers or other light artillery for internal defence, placed as an additional provision against successful assault.

In all cases where the system is intended to be properly applied for coast defence, I should recommend the employment of the most powerful guns available; and the first consideration in placing these guns should be how to get the most out of them in offensive power, and next to consider how they are to be protected from assault. I am convinced that, in the majority of instances, this would not only be the most efficient, but also the more economical method.

I make these observations in this place to show how necessary the 3rd part of the system becomes if the dispositions are carried out on the principles laid down.

The guns would then no longer be compressed into the smallest possible space, in which they offer a temptation for mortar fire, and are sometimes blinded by each others smoke, but they would be spread out and detached; in which case all the arrangements I have mentioned, and others of the same kind, would come into play, and would indeed be necessary.

I shall now pass to the application of the system to naval ordnance.

The value of floating batteries arises from their mobility; and many advocate the employment to a great extent of this method of defence. It has much to be said in its favour, and it will always form a valuable adjunct to land works.

My efforts have been directed to this subject for a long time, and I believe that the counterweight system now adopted by the Government for land works, could be used in floating batteries in smooth water, and in that case would yield in a limited degree some of the advantages gained on land, by enabling low gun barges or iron monitors to work their guns below the water level, and to deliver their fire with the protection of a much smaller iron gunwale than is now required.

I have been baffled, however, in every attempt to apply the system to seagoing vessels, on account of the difficulties imparted by the rolling of the vessel, &c.

I need not dwell on what has been done in applying the system to floating batteries for smooth water, as a long series of investigations in connection with another principle, has led to the development of a new invention for naval service, which will be equally applicable to seagoing vessels and to floating batteries.

This new contrivance is as different from the system now adopted for land service as could be imagined; there is in it neither a moving fulcrum nor a counterweight, which are the grand characteristics of the land service carriages.

Instead of using the force of gravity, pneumatic agency is employed as the balancing force.

Before describing this new invention, and leaving what has already been done, I would ask you to glance again at the system now adopted for land works.

When I went to Woolwich nearly four years ago, by desire of the Secretary of State for War, there was absolutely no satisfactory method of meeting the fire of modern artillery, except by parapets of wrought-iron. Committees appointed to investigate the subject had given forth their decisions that this material alone could be relied on, and both military, and public opinion, had concurred in these decisions.

Preparations for carrying them out were made; and many of the coast works of England, that will now be completed on my system, would by this time (had not that alternative been at hand) have been fitted with as costly bulwarks as are required on our ships of war.

It was contemplated, and indeed it would have been most advisable, to use iron turrets largely in our works; as many as 27 of these for two guns each were estimated for at one time. Later experience has shown that it would probably have been expedient to use only one gun

in each turret. Iron casemates and shields would have been necessary for almost every gun.

It is now probable that no turrets will be required, and an idea of the saving on this item alone may be formed when I mention that a turret with its appliances, without the guns and carriages, costs at the smallest estimate £20,000.

Future works will be erected at a mere fraction of the expense they would have cost without the new system, and the artillery which they mount will at the same time possess much greater offensive power from the increased lateral range.

It will moreover be now possible to form defensive batteries in positions and under circumstances where the expense and other disadvantages would have previously only tempted destruction from ships' fire.

A few light guns can now engage even an iron-clad, whereas previously the expense and difficulty of giving them sufficient protection, would have precluded the idea of using ordinary guns against the powerful ordnance of ships.

A good "Moncrieff emplacement" is as proof against a 600-pounder as against a field piece; and indeed is less likely to receive injury from a few heavy guns than by a corresponding force of smaller pieces; in short, a revolution has taken place in coast attack, and defence.

The Hydro-Pneumatic Carriage.

At a discussion here on the 1st February, 1869, on General Hutchinson's paper,* I stated that I had been working for some years on designs for naval purposes in which the recoil was absorbed by pneumatic agency, and that on some future occasion I should describe at this Institution the method employed. I now redeem my promise, and would enter still more fully into particulars, but for like reasons to those formerly alluded to.

The contrivance which constitutes the new invention is very simple. I have been working up to it for many years, and when I did arrive at the solution, was only surprised that it had escaped me so long.

When a large induction indicates the necessity for a certain device, and at the same time points to generous natural laws lying waste as a means towards that end, the inventor's problem is often solved, as in this case, by some simple expedient that is self-evident when propounded, and which is more or less analogous to a result of natural selection, or to a method of nature herself. Like, I dare say, many others, I have for a long time been trying to derive from pneumatic agency the means for working naval artillery.

The elasticity of air provides the most perfect spring that can be conceived, and in order to utilize the recoil of ordnance it was but required to apply this spring neatly, cheaply and securely. The difficulties of packing, of leakage, of adjustment, &c., stood in the way of this.

* "Recoil Utilized." By Lieut.-General W. N. Hutchinson. See *Journal*, vol. xiii, p. 75, *et seq.*—Ed.

At last, as Watt thought of his separate condenser, I conceived the idea of a separate vessel for my air spring, and of working and adjusting the carriage by hydraulics. As soon as this idea came into my mind, along with the other appliances that belong to it, I felt as certain of success, as of the advantages to be got by it, and accordingly set to work in earnest to arrange the details for its application. The different plans I have worked on for applying this invention, possess many interesting features, and meet in a remarkable manner existing requirements. It is at once economical and efficient, and I have been much gratified by receiving the warm congratulations and encomiums of eminent engineers and scientific men on my contrivance. The actual experiments have more than confirmed the anticipations previously formed. It is suited for vessels of different character, and has many applications.

In a great maritime country like England, anything which is capable of increasing the efficiency of the Navy, must be looked on by all intelligent men as of great importance. We now lean perhaps more than ever on our gallant sailors; and the Navy is indeed more than ever it was before, both our weapon and our shield.

If, therefore, I am able to give our Navy an invention that will go some way to lessen the two greatest difficulties which now attend the armament of its ships, I shall feel conscious of having performed a good service for my country.

The two difficulties which at this moment most hamper the Navy are these—the one is connected with the defence of the ships, the other with their power of attack.

The former is a grave one, as it is nothing more nor less than the difficulty and expense of giving sufficient powers of floatation for the armour that is now required, with the engines, fuel, guns and ammunition of a war ship.

The second difficulty is that of working the ponderous artillery that is now used on board ship; this difficulty I need not dwell on, but it is well understood by the initiated; in some cases even British sailors shrink (at ordinary practice) from the painful duties at the guns.

I hope, gentlemen, to offer to reduce the former difficulty very largely, and to entirely remove the latter.

For reasons which will be understood by inventors, I have not till now been able to divulge the simple process which is employed.

I submitted my plans on the 28th October, 1869, to Mr. Childers and the Admiralty, but this is the first occasion on which I have been able to invite the Naval profession to examine and to criticize these plans, and I await with confidence the judgment that may be pronounced on them to-night in this theatre.

To describe the new process in as few words as possible: it consists in applying the combined action of hydraulics and pneumatics in a variety of ways to heavy ordnance, some of which are illustrated by the diagrams and models.

Let us take one of these, for a 12-ton 9″ gun, as an example. It works on a platform 12 feet in length—that is 4 feet less than a naval slide—traverses on a central pivot along with a small circular portion

of the upper deck, through which the gun rises, and throws back the self-acting shutters which close the horizontal port.

When the gun is fired, it descends into the loading position by the recoil, under cover; if necessary, under the water level.

The force of the recoil is not lost but stored; and the simple operation of turning a cock raises the gun at once, and under perfect control, into the firing position.

The adjustment of this carriage for rolling or for different charges is determined with the most perfect precision to the fraction of a lb. per inch by pressure gauges, and effected with ease and rapidity by arrangements I need not here describe.

The carriage itself, which it will be observed is of the simplest construction, is not connected with, but only rests on, the cross head of the plunger, and all the hydraulic appliances are stowed away in safety at the bottom of the vessel, or wherever it is most convenient to place them.

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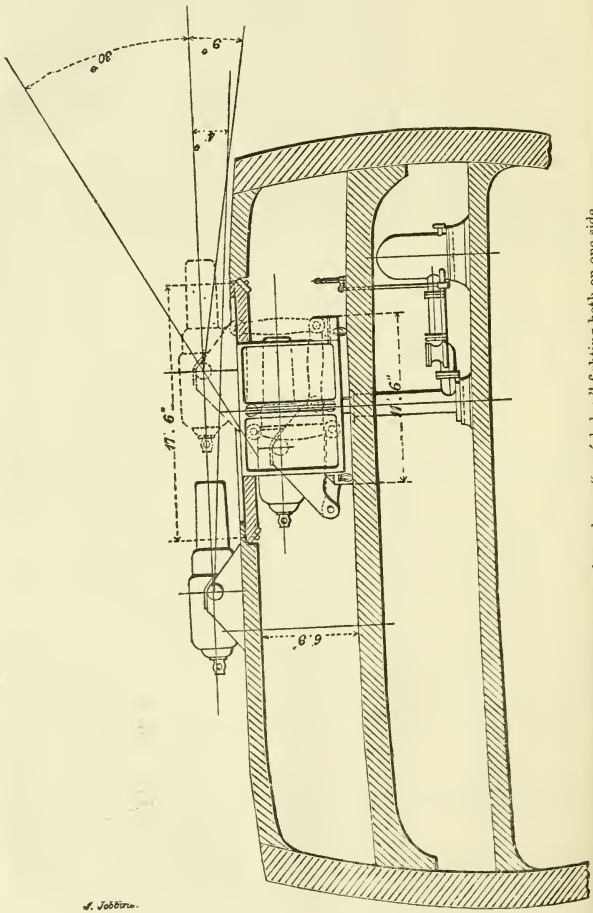
MONCRIEFF REVOLVING HYDRO-PNEUMATIC CARRIAGE.



N.B. The guns are here shown "en échelon," fighting both on one side.

The traversing in this case is done by the engine.

In other cases even the loading is performed mechanically by hydraulics, so that economy of labour is combined with plenty of room for serving the gun, and with the smallest exposure of the men to fire, that has yet been devised.

Whether the method is considered as a possible substitute for the existing broadside or turret systems, I submit that it offers advantages worthy of consideration. In the former case it enables the naval architect to dispense with ports; indeed, with the whole of the armour where the ports are now placed.

An unbroken line of armour without ports is less expensive, and stronger for the same weight.

It removes all those difficulties which encumber the question of training in conjunction with diminished ports, and allows him to adapt any section of the ship's side that gives the greatest resistance without being hampered with questions relating to the thickness of the gunwale, and room for traversing and loading.

It also removes an objection of a serious kind to low ports, viz., that of being submerged on the side to which the vessel heels over. In short, it at once makes unnecessary the expense and the weight of all armour above the deck, and allows the guns to be trained to right or left, without limit or the labour of moving the whole gun on a front pivot.

In the latter case, viz., as a substitute for the turret, it has also something to be said for it.

It possesses many of the advantages of the turret system.

The gun in the firing position is exactly in the same relative position to the deck of the vessel as it would be in a turret, where it is obliged to remain always at that level; it does not, however, as in that case, require a heavy circle of wrought-iron above the deck to protect its carriage and the men serving the gun, as they are all below the deck.

The gun is loaded and worked with greater freedom and ease, with more room and convenience below the deck, and unlike the turret gun, it can be fired at any elevation, however great. The fleet at Lissa would not have been driven off by a few artillerymen at a high battery on shore if there had been even one gun in the fleet mounted with this advantage.

The extra weight of a turret, as estimated by Admiral Halsted, is at least 175 tons, nearly all top hamper. With my system, on the other hand, the weight is only $16\frac{1}{2}$ tons for a 25-ton gun and no top hamper.

The difference in expense is even greater than the difference of weight, great as that may appear. For the fabric of the turret not only costs much money, but the tonnage or displacement of the vessel has to be increased to carry it, and has therefore to be taken into account, and in each vessel this extra carrying power is not purchased very cheaply or conveniently.

Had the system not possessed inherent advantages of its own, independent of economy, the advantage of cheapness alone would have entitled it to consideration.

Sir William Armstrong, in his well-known letter to the *Times* on the 22nd May, 1869, pointed out in an admirable and concise manner the advantages to be gained by vessels of the "Staunch" class, designed by Mr. Rendel. Both Sir William Armstrong and Mr. Rendel are of opinion that the hydro-pneumatic carriage will render these vessels still more effective.

I have been engaged in designing a new class of vessel which becomes practicable with this new method of working naval ordnance. It is simply an adaptation of Mr. Ruthven's most ingenious invention as applied in the "Waterwitch," in combination with the new carriages and other arrangements.*

It will be a creature of singular habits, and addicted to tricks not in keeping with the usages of well-behaved ships. This vessel is designed as a good seagoing craft, with fine lines below water and plenty of freeboard for comfort, and all the qualities that sailors like. She is fitted with hydraulic engines like the "Waterwitch," and built in compartments, but some of these compartments in a proper position in the hull have the following fittings: They have arrangements for opening or closing their communication with the sea. The suckers of the propelling pump can also be made to draw either from the sea or from these tanks. The results of these arrangements are, that when this vessel comes into action she can sink herself almost to the water's edge in a few minutes by opening the before-mentioned compartments to the sea, and with equal rapidity she can empty these tanks by means of her propelling engines whenever that is required.†

It would be an edifying sight to the intruder into a harbour to see a few such vessels dash into their position for action, and immediately sink almost out of sight, and open fire from concealed guns at the water's edge, while they showed nothing more to be attacked than the appearance of a light grey speck in the distance. It is obvious that the same appliance which can expel so large a body of water in four minutes, would also prevent a vessel sinking by shot.

It may occur to those who have thought on this subject, that if this submerging vessel is quite successful, it will probably lead the way to that combination of seagoing, and fighting qualities, in larger vessels, so difficult of attainment—a vessel that can be armoured stronger than the strongest now afloat (where armour is needed), which can be buoyant and high-sided at sea, low and impregnable in fight, with healthy and abundant accommodation for the crew, who need only give up their quarters in actual battle, to retire within their iron fortress in the middle of the ship. The chance of getting a vessel that would combine all these advantages, and at the same time be

* The gun-boat "Waterwitch," with hydraulic propeller, was tried against sister gun-boats "Viper" and "Vixen," with double screw propellers, all three being of same size and horse-power, and the "Waterwitch" gave better results in speed, &c. See Admiral Eliot's able paper in vol. xi of this *Journal*, page 589.

† With reference to the submerging vessel, Plate xxviii, I may mention that the line of extreme submersion is shown, but that the vessel can be fought at any intermediate time between high and low submersion, according to the state of the sea.

BELLEROPHON

CAPTAIN

Scale ¼ Inch = 12 Feet

The parts shaded thus ▓▓ are protected by Armour
The parts shaded thus ▒▒ are unprotected
The parts shaded thus ||||| are submerged Armour

able to keep herself afloat after her hull was pierced, and all this, too, at a greatly reduced price for the same armament, makes the question at any rate worthy of serious consideration, and would justify a greater experiment than is necessary to determine the question.

It may possibly be held that the small command, or height above the water, of guns mounted in some of these vessels, is an argument against the principle; but in answer to this I must state that if the argument be valid, it only applies to the vessel, but not to the principle; if this high command is considered to be necessary, the elevation of the gun can be obtained more cheaply with the new plan than when the carriage is permanently protected in the firing position by iron. I should wish, however, to point out that the maximum difference in height of guns on board ship is very small.

The height of axis of guns above the water level, for the several classes of ships named, is as follows:—

	ft.	in.		ft.	in.
1. Gun-boat	8	0	5. "Hercules"	13	2
2. "Blanche"	11	5	Upper deck	23	8
3. "Volage"	12	0	6. "Monarch" (turret)	17	8
4. "Inconstant"	11	11	7. "Captain" (do.)	9	8
Upper deck	20	0			

At 500 yards the difference of the angle of incidence of a shot fired from a gun 23 feet above the water, and one fired at 8 feet, is practically nothing.

The small shallow-water gunboats, for which this system is well adapted, would not seek close quarters to engage an enemy, and at long range their fire would be practically the same as if obtained from a platform a few feet higher; the additional height would be but a small advantage to them, and at very close quarters they would be under the fire of a large vessel, and so secure.

The question is, would it be worth obtaining greater command at the expense of the additional weight and exposure which is thereby incurred? Where height is considered necessary however, it can be obtained by the new system, with a lower iron bulwark than by any other that has been proposed. From the exposure of the gun in the firing position being only momentary, there would not be much objection to that position being made higher above the deck than it is now.

I shall not discuss this question any longer; it is quite enough to state that the carriage now before you (even though submerging vessels are not adopted, and that depends on whether Ruthven's admirable invention is successfully applied) will at any rate reduce the weight of iron-clads by all that most expensive part of the armour that is above the upper deck—that is, will reduce the displacement by that amount, and consequently the extra expenditure of fuel and engine power required to propel the vessel, and that it will make the service of the guns safer, easier, and possibly more expeditious.

When it is found to perform as much as this, I trust you will consider that I shall then deserve a generous acknowledgment of my success, and that some of the means now being expended on those

plans which it will supersede, may be soon saved to the country by its adoption.

The CHAIRMAN: I am sure that whatever differences of opinion there may be upon the subject of this lecture, you will all agree with me that we are very much indebted to Captain Moncrieff for the trouble and pains he has taken, and the expense he has incurred, in developing these various inventions, and for the very clear manner in which he has explained them to us. I myself am not at all competent to express any opinion whatever upon the subject of artillery, my branch of the service being of a more general kind; therefore, I do not presume, in the presence of an audience of this kind, to say one word about artillery, but, as far as I can understand Captain Moncrieff's principle, it appears to me to be a principle upon which a man can load his gun with the greatest safety to himself, and can use it in the most expeditious manner. With regard to his application of hydraulics and pneumatics, it appears to me to be perfect. But I pronounce no opinion upon it. Probably, there are many gentlemen present who would like to ask some questions; and I have no doubt Captain Moncrieff will be glad to answer them, or, if there is any gentleman who would like to express his opinion upon the subject, it might be of service not only to Captain Moncrieff, but to ourselves as well, as we are all interested in the question, if he would express that opinion. Other gentlemen may have applied their minds to the same subject, and a hint from them may be of great value.

Captain WILKINSON, 16th Lancers: I should be glad to know if you are prepared to employ this new gun for land defences, as well as for sea defences? It seems to me to be an improvement even upon your first gun.

General Sir WILLIAM CODRINGTON: Perhaps Captain Moncrieff will explain how the gun is trained and laid, and also how the shutters are to work. Are they shot proof? and are there any other particulars proposed with regard to the shutters? which appear to me to be an important part of the system for naval guns.

Captain MONCRIEFF: This is not a very good representation of the shutters. Two or three different forms of shutters have been designed, those with counterweights are almost in equilibrium, but have a tendency to close. There are other shutters which are drawn together by the recoil of the gun. The method adopted for this purpose is the following: When the gun descends, the cross head passes down over two rods, which are made with a four-sided spiral. The angle of the spiral is very slow indeed at first. The gun goes down some distance before it acts on it at all; then it begins to act very gradually, and the screw goes on in increasing progression. That screw, or spiral, acts on a pinion, which draws the shutter over the port, and when the gun rises, it opens it again. When the port is closed, you can then walk over it as well as on any other part of the deck. With regard to the question about laying the gun, I propose, in this case, to adopt the same method that is now used with the turret, that is to say, to have man-holes and sights upon the revolving part of the deck. It will at once be observed, that if you lay this part of the deck, you also lay the gun just as you lay the guns by laying a turret. But you have the additional advantage at long range, and where shrapnel fire is not so severe as to make exposure of a man inexpedient, of being able to lay the gun with ordinary sights from the deck, as you would in ordinary practice from an open platform. As I have answered that question, I will now answer the first question with regard to the application of the gun for land defences. I beg to say that I have not yet applied the system to land defences; but I have no doubt whatever, that in some cases, it will be very well adapted for land defence, more especially in the detached iron forts which are used in the defence of Portsmouth harbour. There, I think, the new system might be applied with advantage. The more simple, better known, and readily used plan of counterweights, would, I think, be more suitable for ordinary works.

General Sir WILLIAM CODRINGTON: I do not quite understand about the training. Perhaps Captain Moncrieff will explain it. As I understand him, the training must be done from the deck, and the sighting from the deck, which would require two or three men.

Captain MONCRIEFF: The training of this gun is no more done from the deck than the training is done from the roof of a turret. The training is done below; and, as

I mentioned in my paper, it is done, if necessary, by means of steam power, which would generally be at the disposal of the vessels using this form of arrangement. Of course, it can also be done without steam. In the plan I have matured, the method of training is the following: Underneath this very small and compact carriage there is a toothed wheel, which is in gear with a pinion in communication with the engine. That pinion shaft is again put in gear for right or left action by means of a friction-cone. The gun can thus be trained to right or to left with the greatest nicety and precision by the mere movement of a lever by a slight pressure from the hand. That is the plan which I have matured. Others may, no doubt, be applied, but I imagine that an engineer will consider this method sufficient for the purpose.

Captain FIELD, R.N.: I think that your gun will have to be considerably higher than you now propose to place the axis of the piece, because, although you have designed shutters to cover that opening, any naval officer will, I think, tell you that those shutters will not be sufficient protection for the opening. Therefore you will require considerably higher combings, of 2 feet in height, and that will raise the axis of your piece 2 feet higher than it now is. It would not affect the principle at all, I admit. Then I want to know where the man is to be who shall fire the gun? You say the man can take his aim and fire the gun in the ordinary way. I cannot see where that man will stand. Either he must stand on the platform, and go up and down with the gun, where he will be in a perilous position, or he must have the means of ascending to the deck to fire the gun, and then of being able to step down again. It is clear he can hardly go up and down with the gun itself.

Captain MONCRIEFF: I shall be happy to answer the question. In this plan it is contemplated to have two manholes upon both sides of the gun, with a complete set of sights for both, so that the aiming and the firing can be performed from these manholes with sufficient protection to the men performing these operations. With regard to the observation about the height of the combing, sailors are the best judges of that. All I can say is, that it is possible to make the combing as high as may be required. A tarpaulin might even be left over the gun in the firing position. If the vessel is a low Monitor, it might be advisable to have a combing round the traversing part of the deck, to protect the port from water while it was open. In a vessel with a higher free-board, possibly that might not be required. But a combing can always be supplied with facility; there is no bar against its employment.

Captain JASPER SELWYN, R.N.: I have had the pleasure of being familiar with Captain Moncrieff's inventions since the first time that he brought them before this Institution, and even slightly before that. I have always, as is well known, been strongly impressed in their favour, but that would never make me deviate one iota from what I believe to be the most correct view of the last new invention, by whomsoever made. Now, in this instance, I think Captain Moncrieff has scarcely done himself justice in his explanation of the question, because he has omitted to show that this system admits of the raising of the gun to any possible height that may be necessary. If you wished to raise it 50 feet above the deck, it could be done; there is no difficulty whatever about it; the piston, which operates, would raise the gun to any extent that might be judged advisable. The length of the levers which support the carriage would be the sole measure of the rise of the gun. Secondly, the gun, as is well known to all those who have followed the modern system of pointing by deflection of the rays of light, can be efficiently pointed in almost all instances, except those of very close firing, by means of the mirrors, with even greater accuracy than can be obtained in any other way. The training can be done with perfect mechanical accuracy, such as we have never yet obtained by the use of handspikes, tackles, winches, windlasses, or any other contrivance which has yet been brought before us, since all these are subject to the hurry and confusion of an action, and to the possibility of a shot coming through a port, to which this gun-carriage is not subject. Captain Moncrieff has done himself justice, I think, but not more than justice, in the way in which he has pointed out the enormous advantages to be derived from the absence of useless weights. 275 tons of turret to protect one or two guns, means an addition to the weights to be carried by the ship, which is utterly unjustifiable. The turret is highly objectionable, on account of its position. It is still more to be

objected to by reason that, although we have had many experiments not devoted to the ascertainment of the particular question, we have never yet seen the effect of a single shot in stopping the revolution of the turret, when that shot was applied at or near what are called the combings of the deck. I entirely disagree with the gentleman who thought that high combings were a necessity with the shutters and the revolving apparatus of this gun. If they are so, then we certainly ought to have high combings, which we have not got in the turret vessels. If they are so, then all our knowledge of modern ways of keeping out water and of making close fitting joints are utter fallacies. I think the amount of leakage which might possibly come down from these shutters properly fitted, or from that revolving piece of deck, would be so insignificant, that no one need fear it, more particularly if the hydraulic propeller which Captain Moncrieff has spoken of be fitted to a ship. I believe it to be the very best thing of modern days, only waiting its advancement, as all useful inventions do wait theirs, for the ten years which usually elapse, and which have elapsed, since Captain Moncrieff first tried to force his invention on the attention of the public. That this gun will be valuable for small gunboats I have not the slightest doubt. It will enable us, for the first time, not to put all our eggs in one basket. We shall have an efficient coast defence, without being condemned to see useless hulks, which cannot go to sea, and are ill-adapted for coast defence, rusting to pieces in our harbours. We shall be able to have a mosquito fleet, such as Mr. Scott Russell has spoken of at the Naval Architects, which is infinitely more formidable to an invading foe, because it can be stationed at more points than the number of great unwieldy Monitors we could afford. But the second value of this gun-carriage is in the seagoing ships; and there it will have the value which we all accord to the greatest number of guns carried in the smallest tonnage. Gentlemen who have looked with admiration at the turret vessels, seem to have forgotten how many thousand tons are devoted to carrying how many guns. They have run away with the idea that, because the guns were of great weight compared with former ordnance, therefore it was a great achievement to carry six guns (I will take the outside number that has ever been proposed, not adopted, but proposed) on a vessel of something like 4,000 tons, which vessel would have carried six times the number of guns, aye, I might say twelve times the number of guns of greater weight collectively, throwing, it is true, a less formidable broadside at once, if single shots are taken into the account, but not a much less formidable broadside, if the whole of that broadside is directed to one spot, as gunners know well how to do it. It is a remarkable fact, to which I have before adverted in this Institution, that our experiments in concentrated firing upon armour plates have always missed fire. Somehow or other all the guns which were directed in a concentrated broadside on a target—take six or seven guns as the outside—out of those six or seven guns, perhaps three would miss fire. Well, we do not get—everybody knows we do not get—any measure of results. I hope we may not be dreadfully disappointed when we do get them. But it is certain that whatever gives us the power not only of carrying a greater number of guns, but of carrying equally heavy guns in greater number, is an admirable invention, even if it did not also enable us to carry those guns at sea as low down as it may be convenient for the vessel's capacity to carry them, and perfectly protected without special armour for the purpose. This invention of Captain Moncrieff does do that. I think it is a most admirable invention, and I think we may fairly trust the genius which has given us so great an improvement in our land gun-carriages, which all the world has acknowledged, to give us something for the Navy, which we have long been seeking for, which will give us the means to enable the last man left on board to fire the biggest gun in the ship.

The CHAIRMAN: If no other gentlemen has any observations to make, I beg to return our best thanks to Captain Moncrieff for his lecture, and to wish him success in the cause which he has undertaken.

APPENDIX.

(Copy.)

From General Sir J. L. A. Simmons, K.C.B., R.E., &c., &c.

Woolwich,
4th September, 1869.

Dear Captain Moncrieff,

I have been thinking over the plan you have struck out for mounting guns on board ship, so that, as with your carriages on land, they may fall on being fired, and be concealed below the deck, only to rise again, after being loaded, at the moment when their fire is to be delivered.

The manner in which you accomplish this, by storing up the power generated by the explosion of the gun, without the use of counterweight, as in the carriage invented by you for land service, is most ingenious; it is, at the same time, very simple, will require very little space, and is, in my opinion, sure to succeed, even with the heaviest guns.

The method of utilizing the recoil to compress air, through the agency of water, in the manner proposed by you, thus disposing altogether of the principle you have hitherto adopted of using a counterweight, gives you a power of raising and lowering the gun, by which, I believe, as you say, the heaviest gun will be worked with the same facility as a light gun, except as regards the actual loading, or handling of the charge and projectile.

I concur with you also in thinking that this new contrivance of yours will be capable of most useful application in other ways, and especially in substitution for the water buffer now applied on traversing platforms for checking recoil, although I dare say you will not press its application much in that way, as you are such an enthusiast, you would like to see all guns mounted, so as to rise and fall; but any contrivance which will bring recoil under control for guns firing from casemates, or through portholes, is most valuable, and I trust you will not lose sight of its application in this way, but will press it also upon the Government.

I cannot close this, however, without congratulating you most heartily on your discovery, which will, I firmly believe, produce a great change in our ships of war. It will, I suspect, dispose of the much-vexed turret question, as I cannot conceive that a revolving turret weighing probably 300 tons, exclusive of guns and the machinery to turn it, will ever be adopted, when you can have the power of revolving a gun on a simple turn-table, under the protection of the deck and the armoured sides of the ship. Turrets also have yet to be tried in action. An American who had been in one in action described the effects to me as very formidable; the noise and reverberation caused by a shot striking the turret was most stupefying, and had even killed men inside, without injuring the turret, by the mere concussion of the blow. And then, again, where there is such a heavy mass to move, there must always be a chance of its going wrong, especially when struck; whereas with your invention, the mass to be moved is comparatively light, and is not similarly exposed.

* * * * * * *

Wishing you a speedy success in obtaining an experiment from the Admiralty,

Believe me,

Yours very faithfully,

(Signed) J. L. A. Simmons.

The following is an approximate estimate of the price per gun of works and of ships:—

1st. Works of the most expensive kind, such for instance as—

	Cost per gun.
Horse Sand Fort, with ten 25-ton guns, twenty-four 18-ton guns, and twenty-five 12-ton guns	£8,890

d

	Cost per gun.
Spit Bank Fort, with four 25-ton guns, nine 18-ton guns, and six 7-ton guns	10,900
Portland Breakwater, with fourteen 18-ton guns, and fifteen 12-ton guns	9,500

Average price per gun, £9,600.

2nd. Forts, with granite casemates and iron shields, such for instance as—

Gilkicker Battery, with five 25-ton, seventeen 18-ton, and five 12-ton guns	3,700
Garrison Point Battery, with thirty-six 12-ton guns ..	4,200
Bovisand Battery, with fourteen 18-ton and nine 12-ton guns	3,800

Average price per gun, £3,900.

3rd. Earthen batteries, without iron shields (the addition to these shields would increase the price about £1,300 per gun) for instance—

Southsea Battery, with one 25-ton, twenty-two 12-ton, and nine 7-ton guns	1,270
South Hook Battery, with five 12-ton, and fifteen 7-ton guns	2,290
Warden Point Battery, with four 12-ton, and four 7-ton guns	1,600

Average price per gun, £1,750.

4th. Ships of war, unarmoured and lightly armoured, such for instance as—

"Staunch," gunboat, with one 12-ton gun	6,000
"Inconstant," unarmoured frigate, with sixteen 12-ton guns	13,000
"Caledonia," with 4½ inch iron plating, eight 6-ton guns, six 110 prs., and twelve 68 prs.	11,500
"Royal Sovereign," turret ship, with 5½ inch iron plating, and five 12-ton guns	40,000

Average price per gun, £14,500.

5th. Ships with heavy armour, such for instance as—

"Sultan," with plate from 9 to 6 inches, and twelve 12-ton guns	31,000
"Devastation," turret ship, with plate from 12 to 10 inches, and four 12-ton guns	69,000
"Glatton," turret ship, with 12 to 10 inch armour, and two 12-ton guns	84,300

Average price per gun, £45,000

These averages are not struck alone from the instances given.

Gun for gun, the armament of vessels, is much more expensive than that of works; but it will be borne in mind that ship armament is more valuable than that of forts, owing to its mobility. A gun which can be brought into action at say ten different points within a radius of fifty miles, and in a given time, is so much more formidable to an enemy than one which is stationary. This argument applies in the same manner to guns stored at railway termini with lines radiating to coast positions, provided they can be mounted where most required, within a given time (see p. 8.)

The advantage of employing small vessels for coast defence is suggested by the price of the "Staunch," given in the above tables; and the rapid development of the art of defence by torpedoes or submarine mines, is the argument against large vessels whenever they can be dispensed with; size, however, is necessary to obtain speed.

The problem to be solved is, *What form of war-ship will combine in itself, the greatest economy, sea-going qualities, and power of offence and defence?*

If the suggestions at page 16 are successfully carried out, which they now can be without risk of failure, and at an expense insignificant when compared with the prices in the last table, the country will then possess a proved system that will render it possible to build vessels with heavier armour than any now afloat; which will be as good sea boats as any unarmoured vessel; and which will carry the heaviest artillery our arsenals can produce.

Every one of the above conditions are now within reach; and I am assured by the best authorities in England that an actual speed of 15 knots can be given in addition to them.

It is unnecessary to compare a vessel of such qualities with the best now afloat. When it may be stated that this country can obtain the means of mounting the heaviest artillery in ships with an all-round fire without revolving turrets; of a propelling power that will both drive a ship at high speed, and prevent her from sinking if injured in action; and of designs that will make a war ship not only the best sea boat, but in action the strongest monitor, I earnestly submit that at any rate the first step should be taken by a great maritime nation like England, to verify the truth of such statements, and to encourage any person who ventures to bring them forward with sufficient evidence as to their complete success.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.